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FUNCTIONAL FORM AND THE DIVIDEND EFFECT IN THE ELECTRIC UTILITY INDUSTRY

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GORDON [5], DURAND [3], AND OTHERS have employed either linear or logarithmic linear relationships between prices and both dividends and retained earnings to explain price variations in cross-section samples of companies drawn from a particular industry. They have concluded that the divident multiplier in general is several times the retained earning multiplier. However, Friend and Puckett [4] have detected the existence of possible specification biases in previous studies of the importance of the divident effect relative to the retained earning effect.[1] For the electric utility industry, they found that evidences of the relative importance between the dividend effect and the retained earning effect are not independent of the functional forms—linear and logarithmic—being employed to test the relationship among the price, dividends, and the retained earnings. They concluded that it is not possible to choose conclusively between the linear and the logarithmic results on statistical or *a priori* grounds. In addition, they concluded that the linearity assumption employed by them and others is relatively restrictive.

The main purpose of this paper is to determine the most appropriate functional form for investigating the dividend effect of the electricity industry in accordance with the generalized functional form (GFF) developed by Box and Cox [1]. Both linear and logarithmic functional forms are treated as a special case of the GFF. The GFF allows us to choose conclusively between the linear and the logarithmic results of the dividend effect wholly on statistical grounds. It also allows testing whether a nonlinear instead of a linear functional form should be used to investigate the dividend effect in the electric utility industry. In the first section, models are developed to test the dividend effect. The procedure employed to estimate the functional form parameter also is specified. In the second section, 116 electric utility companies from the Compustat are employed to investigate the importance of the dividend effect relative to the retained earning effect on the basis of the GFF. Logarithmic results are shown to be statistically more suitable for investigating the dividend effect. In addition, the nonlinear instead of the logarithmic linear functional form is found more suitable for investigating dividend effect. Furthermore, some implications of different functional forms in investigating the dividend effect are discussed. The last section provides a summary and concluding remarks.

I. THE MODEL

Following Box and Cox [1] and Zarembka [6], a generalized deterministic relationship between the stock price, dividends and retained earning is defined as

$$P_{ti}^{\lambda} = l_0 + l_1 D_{ti}^{\lambda} + l_2 R_{tt}^{\lambda} \tag{1}$$

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1. Their study covered chemical, electronic, electric utility, food and steel industries.

where P_{ti}, D_{ti}, and R_{ti} represent per share price, dividend, and retained of ith company earnings in the tth period respectively. λ is the functional form parameter to be estimated. Equation (1) will become a linear form when λ is equal to one; equation (1) will reduce to a logarithmic linear form when λ approaches zero.[2] In other words, equation (1) includes both the linear and the logarithmic form as a special case and provides a generalized functional form (GFF) for testing the dividend effect. In order for equation (1) to be continuous at $\lambda = 0$ and stochastic, it should be rewritten as

$$P_{ti}^{(\lambda)} = l_0' + l_1 D_{ti}^{(\lambda)} + l_2 R_{ti}^{(\lambda)} + \tau_{ti} \tag{2A}$$

where

$$P_{ti}^{(\lambda)} = \frac{P_{ti}^{\lambda} - 1}{\lambda}, \qquad D_{ti}^{(\lambda)} = \frac{D_{ti}^{\lambda} - 1}{\lambda},$$

$$R_{ti}^{(\lambda)} = \frac{R_{ti}^{\lambda} - 1}{\lambda}, \qquad l_0' = \frac{(l_0 + l_1 + l_2) - 1}{\lambda} \tag{2B}$$

and

$$\tau_{ti} \sim N(0, \sigma_\tau^2)$$

Using the maximum likelihood method, Box and Cox [1] derived a maximum logarithmic likelihood for determining the functional form parameter as

$$L \max(\hat{\lambda}) = -n \log \hat{\sigma}_\tau(\lambda) + (\lambda - 1) \sum_{i=1}^{n} \log P_{ti} \tag{3}$$

where n is the sample size, and $\hat{\sigma}_\tau(\lambda)$ is the estimated regression residual standard error of equation (2A). After the $\hat{\sigma}_\tau(\lambda)$ being estimated equation (3) is employed to determine the optimum value of the functional form parameter, λ. The optimum value of λ is obtained by plotting equation (3) for different values of λ to arrive at the maximized logarithmic likelihood over the whole parameter space. Using the likelihood ratio method, an approximate 95% confidence region for λ can be obtained from

$$L \max(\hat{\lambda}) - L \max(\lambda) < \tfrac{1}{2}\chi_1^2(.05) = 1.92 \tag{4}$$

The 95% confidence region for λ subsequently is used to determine the true functional form in investigating the divident effect.

II. Functional Form and the Dividend Effect

Some 116 electric utility companies are used to investigate the divident effect relative to the retained earnings effect. For determining the true functional form

2. Zarembka [6] has employed the generalized functional form technique to determine the true functional for money demand. The proof of this statement can also be found in his paper.

parameter, P_t, D_t and R_t are transformed in accordance with equation (2B) by λ's between −0.1 and 1.0 at intervals of length 0.1. Twelve different regressions are estimated for each year in accordance with the procedure described above.[3] The L max(λ) for 1960 is calculated using equation (3) and plotted in Figure I. Vertical lines are drawn to indicate the approximate 95% confidence region. Note that $\hat{\lambda}$ for 1960 is about .55 and is significantly different from both the linear ($\lambda = 1$) and logarithmic ($\lambda = 0$) forms. Following the similar procedure employed for 1960, the maximum likelihood estimates of λ for the period during 1961–1969 are estimated. The maximum likelihood estimates of λ and their confidence regions for ten sample years are given in Table 1. All the true functional forms in investigating the

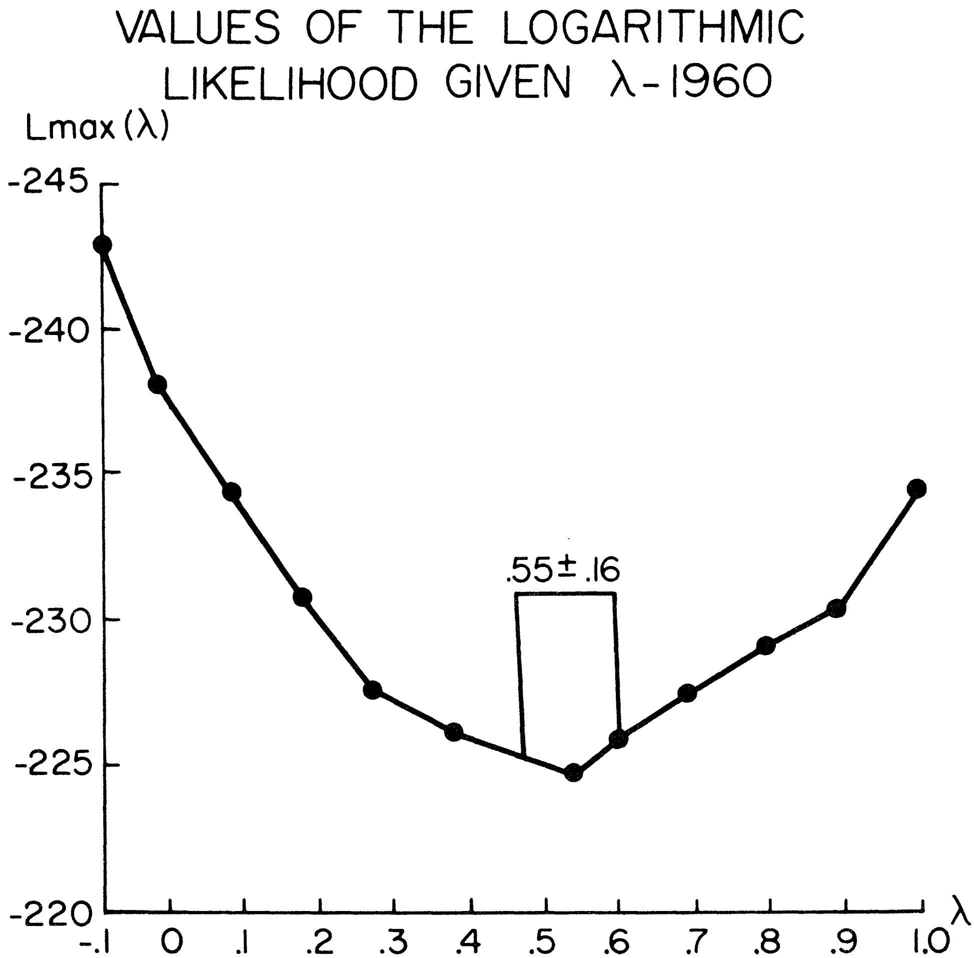

FIGURE 1 Value of the Logarithmic Likelihood Given λ − 1960

3. Since a company with negative retained earning is not included in the regression, therefore, the sample size is 110, 114, 115, 115, 115, 116, 116, 116, 116 and 116 for 1960, 1961, 1962, 1963, 1964, 1965, 1966, 1967, 1968 and 1969 respectively.

TABLE 1

THE MAXIMUM LIKELIHOOD ESTIMATES OF λ AND THEIR RELATED REGRESSION PARAMETERS

Years	$\hat{\lambda}$	95% Confidence Region for $\hat{\lambda}$	l_1	l_2
1960	.55	$.55 \mp .16$	2.85986	3.63352
1961	.55	$.55 \mp .01$	3.66002	4.13767
1962	.25	$.25 \mp .25$	1.11466	1.11100
1963	.35	$.35 \mp .30$	1.58914	1.63041
1964	.45	$.45 \mp .41$	2.32391	2.56805
1965	.35	$.35 \mp .29$	1.68970	1.70573
1966	.35	$.35 \mp .32$	1.61676	1.31104
1967	.05	$.05 \mp .10$	.66763	.34821
1968	.05	$.05 \mp .12$	.69266	.32054
1969	−.10	$-.10 \mp .18$	.42596	.17736

dividend effect for these ten sample years are all significantly different from the simple linear form. In addition, the true functional forms for 1960, 1961, 1963, 1964, 1965 and 1966 are also significantly different from the logarithmic linear form.

The regression coefficients associated with different λ's are employed to analyze the relationship between the functional form and the divident effect. From the results of linear ($\lambda = 1$) form, the retained earning effect is stronger than the dividend effect for nine sample years; from the results of logarithmic linear ($\lambda = 0$) form, the dividend effect is stronger than the retained earning effect for all ten sample years. These inconsistent results are essentially identical to those found by Friend and Puckett [4]. However, if results from the true functional form are used to make comparisons, the dividend effect is almost identical to the retained earning effect for the years 1961, 1962, 1963, 1964, 1965 and 1966, and the dividend effect is different from the retained earning effect for the years 1960, 1967, 1968 and 1969 [See Table 2]. In sum, *a priori* (and arbitrary) choice of λ (e.g., one or zero) not only can lead to misspecification of the functional form but also can lead to an incorrect

TABLE 2

ANNUAL AVERAGED DIVIDEND AND RETAINED EARNING PDR SHARE DURING 1960–1969

Years	Averaged Dividend Per Share	Averaged Retained Earning Per Share
1960	1.47309	.75790
1961	1.43855	.69721
1962	1.31281	.68399
1963	1.24488	.62380
1964	1.22491	.65021
1965	1.21557	.65808
1966	1.23268	.68144
1967	1.29834	.69983
1968	1.33792	.64716
1969	1.37976	.70324

conclusion about the importance of dividend effects relative to the retained earning effects.

The main disadvantage of employing the simple linear regression to investigate the dividend effect is that the regression coefficients are not always free from the scale effect.[4] If the pay-out ratio is higher than the retention rate for most of the companies in a particular industry, then the coefficient of the dividend variable will be generally smaller than that of the retained earning variable. From Table 2, it can be shown that the averaged retention rate is about 1/2 of the average pay-out ratio for every sample year, therefore, the lower dividend effect, relative to the retained earning effect, may essentially be due to the scale effect of regression analysis. Similarly, if an industry's average retention rate is much higher than its pay-out ratio, then the scale effect may be so strong as to lead us to mistakenly conclude that the dividend effect is stronger than the retained earning effect.

The main advantage of the logarithmic relation is to reduce the problem of regression weights even though it fails to take care of negative retained earnings.[5] If the relation used to investigate the dividend effect for any year is significantly different from both the linear and the logarithmic relations, then one cannot separate the effects of the dividend on the stock price from those of the retained earning because the relation used to investigate the dividend effect is no longer linear in parameter. Hence, equation (1) is rewritten as

$$P_{ti} = \left[l_0 + l_1 D_{ti}^{\lambda} + l_2 R_{ti}^{\lambda} \right]^{1/\lambda} \tag{5}$$

Equation (5) implies that effects of the dividend and the retained earning on the stock price are interrelated. This specification is indeed consistent with the theoretical relationship between the dividend and the retained earning. For the GFF of (5), the statistical tests here have entirely rejected the linear ($\lambda = 1$) relation for all ten sample years being used in this paper. These findings imply that the traditional cross-section investigations of the dividend effect in the electric utility industry have failed to employ a correct functional form. Thus conclusions for the importance of the dividend effect relative to the retained earning effect are subject to specification bias. The functional form analysis of this paper is not identical to that of Friend and Puckett since the purposes of their studies are to investigate the effects of omitting variables on the regression coefficients while the main purpose of this study is to determine the true functional form which they have regarded as an open question.

III. Summary and Concluding Remarks

A generalized functional form is developed here in order to determine the relationship among the stock price, dividends and retained earnings. The linear form (sometimes even the logarithmic linear form) is not a correct functional form for

4. However, the linear regression can handle satisfactorily very small and negative retained earnings.

5. See Friend and Puckett [4, p. 672] for details. Draper and Cox [2] have shown that the failure of permitting the negative real value in power transformation does not reduce the usefulness of GFF.

investigating the dividend effect of the electric utility industry. Moreover, the dividend effect is not significantly different from the retained earning effect for 60% of the cross-section results after the true functional relationship has been determined. Essentially, the GFF explicitly takes the interrelation between dividends and retained earnings into account; the functional form parameter also reflects the different relationship among the stock price, dividends and retained earnings under different economic conditions.[6] In sum, it has been established that the previous studies of determining the dividend effect of the electric utility industry may have pre-judged an important issue—the correct functional form. While linear and logarithmic forms are easy to handle, this consideration alone is not enough to justify employment of either of these forms. In fact, it has been shown that there exists a generalized functional form which allows a compact analysis of the effects of choice of functional form on determining the dividend effect of the electric utility industry.

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6. This remark is based upon the classification of estimated λ's (See Table 1). For reflecting the impact of economic conditions on the dividend effect, Friend and Puckett [4] employed the data from 1956 and 1958 to represent a bear market and a bull market respectively. However, they could not find any evidence to support their assumption.